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From Biodiversity to Drug Discovery: Pharmacological Significance and Conservation of Endangered Medicinal Plants

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ABSTRACT
Background: Medicinal plants have served as a cornerstone for drug discovery and traditional healthcare systems for centuries. However, a significant proportion of these biologically valuable species are currently threatened due to anthropogenic pressures and ecological changes. **Objective:** This review aims to critically evaluate pharmacologically important endangered medicinal plants, focusing on their phytochemical composition, therapeutic potential, and conservation challenges. **Methods:** A comprehensive literature survey was conducted using databases such as PubMed, Scopus, and Web of Science, covering publications from 2021 to 2026. Studies were selected based on relevance to endangered status, pharmacological validation, and phytochemical characterization. **Results:** Several endangered plants, including *Rauvolfia serpentina*, *Coscinium fenestratum*, *Angelica glauca*, *Chlorophytum borivilianum*, and *Saussurea costus*, exhibit significant pharmacological activities such as antihypertensive, antimicrobial, anti-inflammatory, immunomodulatory, and anticancer effects. These activities are attributed to diverse phytoconstituents including alkaloids, flavonoids, terpenoids, and glycosides. **Conclusion:** Endangered medicinal plants represent a valuable yet diminishing resource for drug discovery. Integrating pharmacological research with conservation strategies is essential to ensure sustainable utilization and preservation of these species.
Keywords: Endangered medicinal plants; phytochemistry; drug discovery; conservation biology; ethnopharmacology

Introduction

Medicinal plants constitute a fundamental component of traditional and modern therapeutic systems. Plant-derived remedies serve as the primary healthcare option for nearly four-fifths of the world's population[1], with the greatest reliance seen in developing countries. Additionally, nearly 25% of modern pharmaceuticals are derived directly or indirectly from plant sources[2,3]. Despite their immense value, medicinal plants are increasingly threatened. Factors such as overharvesting, habitat destruction, climate change, urbanization, and unsustainable trade practices have led to a rapid decline in plant biodiversity. According to recent global assessments, thousands of medicinal plant species are now categorized under various threat levels, including vulnerable, endangered, and critically endangered.

India, recognized as one of the world's biodiversity hotspots, harbors a vast diversity of medicinal flora. However, many species used in Ayurveda, Siddha, and Unani systems are facing extinction risks[4-6]. The loss of these plants not only threatens ecological balance but also limits future opportunities for drug discovery.This review focuses on pharmacologically important endangered medicinal plants, emphasizing their phytochemistry, therapeutic applications, and conservation strategies[7].

The integration of pharmacological research with biodiversity conservation is crucial for sustainable healthcare development[8].

Methodology

A systematic literature review was conducted using electronic databases including PubMed, Scopus, Google Scholar, and Web of Science. The search covered publications from 2021 to 2026 using keywords such as:

- Endangered medicinal plants
- Pharmacological activity
- Phytochemistry
- Ethnopharmacology
- Conservation strategies

The selected studies were critically analysed and categorized based on pharmacological activity, phytochemical composition, and conservation status.

Overview of Endangered Medicinal Flora

Endangered medicinal plants are species at risk of extinction due to environmental and anthropogenic pressures. The International Union for Conservation of Nature (IUCN) classifies species into categories such as vulnerable, endangered, and critically endangered based on population trends and distribution[1].

Causes of Endangerment

- Overexploitation for pharmaceutical and commercial purposes. Habitat demolition due to deforestation and urbanization
- Climate change affecting growth and distribution

- Lack of sustainable harvesting practices

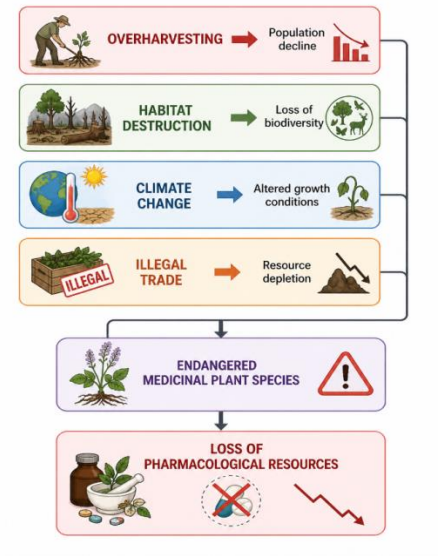


Figure: 1

Importance in Pharmacology

Endangered plants often contain unique bioactive compounds with significant therapeutic potential. Many clinically important drugs, such as reserpine and vincristine, have originated from plant sources.

Pharmacologically Important Endangered Medicinal Plants

Endangered medicinal plants constitute a vital reservoir of bioactive compounds with significant therapeutic potential. Several of these species have been extensively studied for their phytochemical composition and pharmacological activities, yet remain under threat due to unsustainable exploitation. The following section highlights key endangered plants with established pharmacological importance.

Rauvolfia serpentina

Rauvolfia serpentina (Family: Apocynaceae), commonly known as Indian snakeroot, is one of the most extensively studied medicinal plants due to its rich alkaloidal content and established therapeutic applications. The plant contains a wide range of indole alkaloids, including reserpine, ajmaline, and serpentine, which are primarily responsible for its pharmacological activity[9].

Among these, reserpine has been widely used as an antihypertensive and antipsychotic agent. Its mechanism of action involves irreversible inhibition of vesicular monoamine transporters (VMAT), leading to depletion of catecholamines such as norepinephrine, dopamine, and serotonin from presynaptic nerve terminals. This results in reduced sympathetic activity and a consequent decrease in blood pressure, along with sedative effects[10].

Despite its significant therapeutic value, *R. serpentina* has become endangered due to extensive harvesting for pharmaceutical purposes and habitat loss. The continued demand for its alkaloids in the treatment of hypertension and psychiatric disorders has further exacerbated its depletion, highlighting the urgent need for conservation and supportable cultivation strategies.

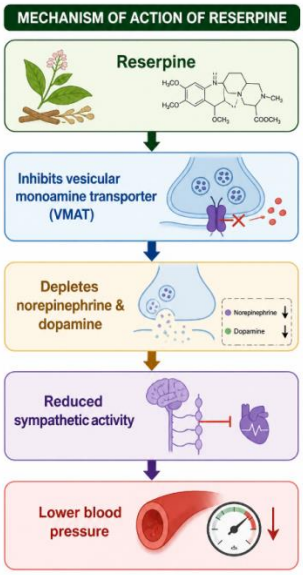
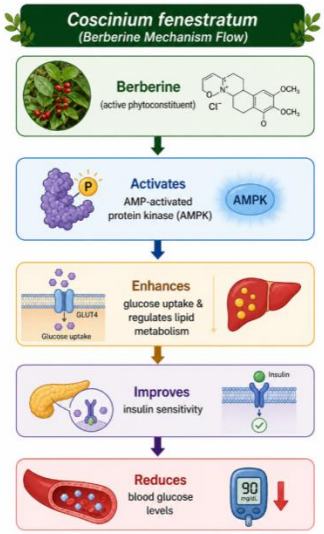


Figure: 2

Coscinium fenestratum

Coscinium fenestratum (Family: Menispermaceae) is a critically endangered medicinal plant known for its high content of isoquinoline alkaloids, particularly berberine. This compound has attracted considerable scientific interest due to its diverse pharmacological properties, including antidiabetic, antimicrobial, and anti-inflammatory activities[11].Berberine exerts its antidiabetic effects primarily through activation of AMP-activated protein kinase (AMPK), which plays a central role in regulating glucose and lipid metabolism. Additionally, it exhibits antimicrobial activity by disrupting microbial cell membranes and inhibiting nucleic acid synthesis[1].The plant is extensively used in traditional medicine systems, particularly in South and Southeast Asia, for the treatment of metabolic and infectious diseases. However, unsustainable harvesting practices, particularly the extraction of stems and roots, have led to a drastic decline in its natural populations. Consequently, *C. fenestratum* is now classified as critically endangered, necessitating immediate conservation interventions.



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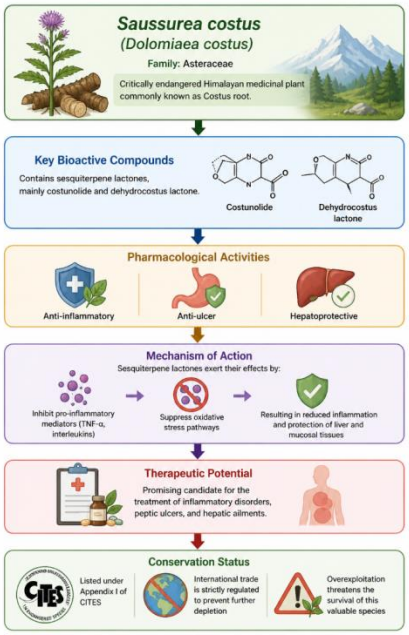
Saussurea costus (Dolomiaea costus)

Saussurea costus (Family: Asteraceae), also known as costus root, is a critically endangered Himalayan medicinal plant valued for its sesquiterpene lactones, including costunolide and dehydrocostus lactone[12]. These compounds are known to exhibit potent anti-inflammatory, anti-ulcer, and hepatoprotective activities.

The pharmacological effects of these lactones are primarily mediated through inhibition of pro-inflammatory mediators such as Tumor Necrosis Factor-alpha (TNF-α) and interleukins, as well as suppression of oxidative stress pathways[13]. These properties make *S. costus* a promising candidate for the treatment of inflammatory and hepatic disorders. Due to its high medicinal value and extensive use in traditional and modern medicine, the species has been subjected to excessive exploitation. It is currently listed under Appendix I of the Convention on International Trade in Endangered Species (CITES), indicating that international trade is strictly regulated to prevent further depletion.



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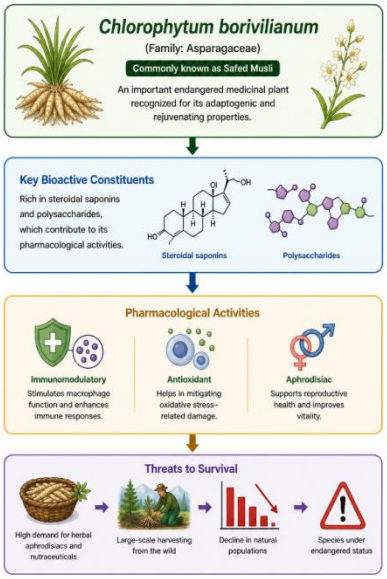
Chlorophytum borivilianum

Chlorophytum borivilianum (Family: Asparagaceae), commonly known as safed musli, is an important endangered medicinal plant recognized for its adaptogenic and rejuvenating properties. The plant is rich in steroidal saponins and polysaccharides, which contribute to its pharmacological activities.These bioactive constituents exhibit significant immunomodulatory, antioxidant, and aphrodisiac effects. The immunomodulatory activity is attributed to the stimulation of macrophage function and enhancement of immune responses, while antioxidant properties help in mitigating oxidative stress-related damage[13].

The growing demand for herbal aphrodisiacs and nutraceuticals has led to large-scale harvesting of this plant from the wild. As a result, natural populations have declined significantly, placing the species under endangered status. Cultivation practices have been introduced; however, challenges related to standardization and quality control persist.



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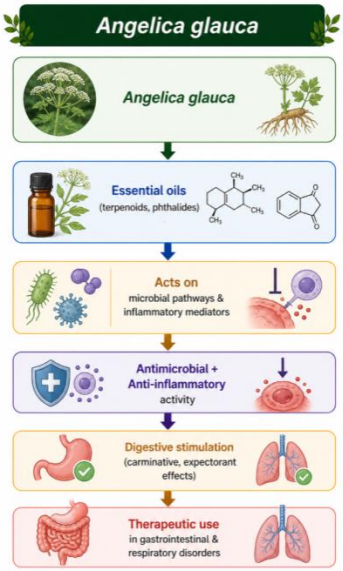
Angelica glauca

Angelica glauca (Family: Apiaceae) is an endangered medicinal plant native to the Himalayan region[14]. It is widely used in traditional medicine for the treatment of digestive, respiratory, and inflammatory disorders. The plant contains essential oils rich in terpenoids and phthalides, which are responsible for its pharmacological activities. Studies have demonstrated that these compounds exhibit antimicrobial, anti-inflammatory, and digestive stimulant properties[15]. The plant is particularly valued for its carminative and expectorant effects, making it useful in gastrointestinal and respiratory ailments.Despite its therapeutic importance, *A. glauca* faces significant threats due to overharvesting and limited natural regeneration. Its restricted geographic distribution further increases its vulnerability, necessitating focused conservation efforts.



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Siphonochilus aethiopicus

Siphonochilus aethiopicus (Family: Zingiberaceae), commonly known as African ginger, is a threatened medicinal plant traditionally used for the treating of respiratory disorders, including asthma and colds. The plant contains a diversity of terpenoids and essential oils that contribute to its pharmacological properties.These compounds exhibit anti-inflammatory and bronchodilatory effects, supporting its traditional use in managing respiratory conditions. Additionally, antimicrobial activity has been reported, further enhancing its therapeutic potential.However, habitat devastation and overharvesting have led to a significant decline in its natural populations. Preservation efforts are currently underway, but the species remains at risk due to continued exploitation and limited cultivation initiatives.

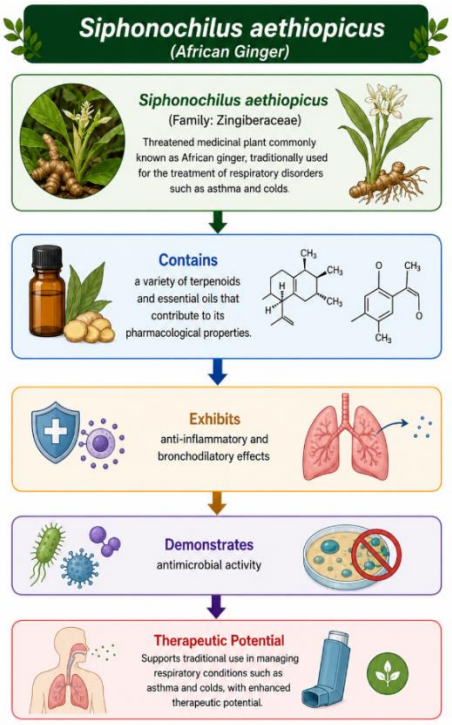

Figure: 7

Conservation Status

Threatened due to habitat loss.

Phytochemistry–Pharmacology Correlation

The pharmacological effects of medicinal plants are closely linked to their phytochemical constituents. Alkaloids, flavonoids, terpenoids, and glycosides exhibit diverse therapeutic activities through interactions with biological targets such as enzymes and receptors[16,17].Investigating these relationships is vital for advancing drug discovery efforts and confirming the effectiveness of traditional medicine practices.

Conservation Strategies

The conservation of threatened medicinal plants is vital to ensure sustainable utilization, biodiversity preservation, and continued availability of pharmacologically active compounds. A multidisciplinary approach combining ecological, biotechnological, and policy-driven strategies is required to mitigate the rapid depletion of these valuable plant resources [18,19].

In Situ Conservation

In situ conservation involves the protection and maintenance of plant species within their natural habitats, allowing them to evolve under natural environmental conditions. This approach is considered the most effective strategy for conserving genetic diversity and ecological integrity[20].

Protection of Natural Habitats

Preservation of forests, grasslands, and alpine ecosystems is critical for maintaining native medicinal plant populations. Habitat destruction due to deforestation, mining, and urbanization remains a major threat. Conservation efforts should focus on:

- Preventing illegal logging and land-use changes
- Promoting sustainable forest management
- Reestablishing degraded ecosystems

Establishment of Biosphere Reserves and Protected Areas

The creation of protected areas such as national parks, wildlife sanctuaries, and biosphere reserves plays a crucial role in safeguarding endangered medicinal plants. These regions act as genetic reservoirs and support ecological balance. Community-based conservation models within buffer zones have also proven effective in integrating local populations into conservation efforts[21].

Ex Situ Conservation

Ex situ conservation refers to the preservation of plant species outside their natural habitats. This strategy is particularly useful for critically endangered species with declining populations or limited geographic distribution[22].

Botanical Gardens

Botanical gardens serve as living repositories of medicinal plant diversity. They facilitate:

- Preservation of rare and rare species
- Public awareness and education
- Research on plant biology and pharmacology

Seed Banks

Seed banks store viable seeds under controlled conditions for long-term preservation. They provide a genetic backup that can be used for future restoration programs and research. Cryopreservation techniques further enhance the longevity of stored genetic material[23].

Tissue Culture Techniques

Plant tissue culture offers a powerful tool for the rapid propagation of threatened species. Techniques such as micropropagation, somatic embryogenesis, and organogenesis enable:

- Mass multiplication of elite genotypes
- Conservation of genetically uniform plants
- Production of disease-free planting material

This approach is particularly valuable for plants with low seed viability or slow natural regeneration [24].

Sustainable Utilization

Sustainable utilization ensures that medicinal plant resources are used in a manner that does not compromise their long-term availability.

Controlled Harvesting

Unregulated harvesting is a major cause of plant depletion. Sustainable harvesting practices include:

- Rotational harvesting

- Harvesting specific plant parts (e.g., leaves instead of roots)
- Seasonal collection to allow regeneration

Cultivation Practices

Domestication and cultivation of medicinal plants reduce pressure on wild populations. Cultivation offers several advantages:

- Standardization of raw materials
- Improved yield and quality
- Economic benefits to farmers

Good Agricultural and Collection Practices (GACP) should be implemented to ensure quality and sustainability[25].

Community Involvement

Local communities play a vital role in conservation. Indigenous knowledge systems contribute to bearable resource management. Community-based initiatives such as:

- Participatory forest management
- Benefit-sharing mechanisms
- Awareness programs

have shown significant success in conserving medicinal plant biodiversity[21].

Policy and Regulation

Effective conservation requires strong legal and institutional frameworks.

Implementation of Biodiversity Laws

National policies such as biodiversity acts regulate access, conservation, and sustainable use of biological resources. These laws aim to:

- Prevent biopiracy
- Promote equitable benefit sharing
- Encourage conservation efforts

International Agreements

Global frameworks such as the Convention on International Trade in Threatened Species of Wild Fauna and Flora (CITES) regulate the trade of endangered medicinal plants. These agreements help prevent illegal exploitation and ensure sustainable international trade[26]

Conclusion

Endangered medicinal plants represent a vital resource for pharmacological innovation. Their rich phytochemical diversity offers immense potential for drug development. However, unsustainable exploitation threatens their survival. A multidisciplinary approach integrating pharmacology, conservation biology, and policy implementation is essential to preserve these valuable resources for upcoming generations.

Conflict of Interests

The authors declare no conflict of interest

Ethics Approval: Not applicable

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AI Tool Declaration

The authors declare that no AI and related tools are used to write the scientific content of this manuscript.

References

[1] Chen SL, Yu H, Luo HM, Wu Q, Li CF, Steinmetz A. Conservation and sustainableuse of medicinal plants: problems, progress, and prospects. Chin Med. 2016 Jul30;11:37. doi: 10.1186/s13020-016-0108-7.

[2] World Health Organization. WHO guidelines on good agricultural and collectionpractices (GACP) for medicinal plants. Geneva: WHO; 2003.

[3] Yuan H, Ma Q, Ye L, Piao G. The Traditional Medicine and Modern Medicine fromNatural Products. Molecules. 2016 Apr 29;21(5):559. doi:10.3390/ molecules21050559.

[4] Newman DJ, Cragg GM. Natural products as sources of new drugs over the nearly four decades from 01/1981 to 09/2019. J Nat Prod. 2020;83(3):770-803. doi:10.1021/acs.jnatprod.9b01285.

[5] Atanasov AG, Zotchev SB, Dirsch VM, International Natural Product Sciences Taskforce, Supuran CT. Natural products in drug discovery: advances and opportunities. Nat Rev Drug Discov. 2021;20(3):200-216. doi:10.1038/s41573-020-00114-z.

[6] Dias DA, Urban S, Roessner U. A Historical Overview of Natural Products in DrugDiscovery. Metabolites. 2012; 2(2):303-336. doi.org/10.3390/metabo2020303.

[7] Gowthami R, Sharma N, Pandey R, Agrawal A. Status and consolidated list of threatened medicinal plants of India. Genet Resour Crop Evol. 2021;68(6):2235-2263. doi: 10.1007/s10722-021-01199-0. Epub 2021 May 25. PMID: 34054223; PMCID: PMC8148398.

[8] Anmol, Aggarwal G, Sharma M, Singh R, Shivani, Sharma U. Ethnopharmacologically important highly subsidized Indian medicinal plants: Systematic review on their traditional uses, phytochemistry, pharmacology, quality control, conservation status and future prospective. J Ethnopharmacol. 2024; 320: 117385.doi:10.1016/j.jep.2023.117385.

[9] Kumar S, Kumari D, Singh B. Genus Rauvolfia: A review of its ethnopharmacology, phytochemistry, quality control/quality assurance, pharmacological activities and clinical evidence. J Ethnopharmacol. 2022; 295:115327. doi:10.1016/j.jep.2022.115327.

[10] Sharma P, Roy M, Roy B. A review on influence of floral biology, pollination efficiency and conservation strategies of endangered medicinal plant, Rauvolfia serpentina (L.) Benth. ex Kurz. Ann Phytomed. 2022; 11(1):86-98. doi:10.54085/ap.2022.11.1.9.

[11] Imenshahidi M, Hosseinzadeh H. Berberine pharmacology: A review. Front Pharmacol. 2022; 13: 843787. doi:10.3389/fphar.2022.843787.

[12] Ali SI, Venkatesalu V. Botany, traditional uses, phytochemistry and pharmacological properties of Saussureacostus An endangered plant from Himalaya: A review. Phytochem Lett. 2022; 47: 140–155. doi:10.1016/ j.phytol.2021.12.008.

[13] Khanam Z, Singh O, Singh R, Bhat IU. Safed musli (Chlorophytum borivilianum): a review of its botany, ethnopharmacology and phytochemistry. J Ethnopharmacol. 2013; 150(2): 421-441. doi:10.1016/ j.jep.2013.08.064.

[14] Kaur A, Bhatti R. Understanding the phytochemistry and molecular insights to the pharmacology of Angelica archangelica L. (garden angelica) and its bioactive components. Phytother Res. 2021; 35(11): 5961-5979. doi:10.1002/ptr.7206.

[15] Gautam K, Raina R, Dikshit N. Current knowledge on sustainability and conservation of endangered Himalayan medicinal herb Angelica glaucaEdgew.—A review. J Herb Med. 2023; 42: 100764. doi:10.1016/ j.hermed.2023.100764.

[16] Mudau FN, Chimonyo VGP, Modi AT, Mabhaudhi T. Neglected and Underutilised Crops: A Systematic Review of Their Potential as Food and Herbal Medicinal Crops in South Africa. Front Pharmacol. 2022 Jan 20;12:809866. doi: 10.3389/ fphar.2021 .809866.

[17] Thiruvengadarajan VS, Rajasekaran A, Manimegalai A, Muthukumar VL, Mathialagan P, Santhosh VS, Thamayanthi T. A review of vulnerary application of selected medicinal plants in traditional health care. Pharmacogn Rev. 2026;20(39):41-47. doi:10.5530 /phrev. 20260034.

[18] Efferth T, Koch E. Complex interactions between phytochemicals. The multi-targettherapeutic concept of phytotherapy. Curr Drug Targets. 2011 Jan;12(1):122-32. doi:10.2174/138945011793591626.

[19] Singh, K., Gupta, J.K., Chanchal, D.K. et al. Natural products as drug leads: exploringtheir potential in drug discovery and development. Naunyn-Schmiedeberg ArchPharmacol. 2025; 398, 4673–4687. doi.org/ 10.1007/s00210-024-03622-6

[20] Tripathi, Leena & Tripathi, Jaindra. (2005). Role of biotechnology in medicinalplants. Tropical Journal of Pharmaceutical Research. 2. 243-253.10.4314/ tjpr. v2i2.14607.

[21] Al-Qurainy F, Tarroum M, Khan S, Nadeem M, Gaafar A-RZ, Alansi S, Alfarraj NS.Genome Estimation and Phytochemical Compound Identification in the Leaves and Callus of Abrus precatorius: A Locally Endangered Plant from the Flora of SaudiArabia. Plants. 2022; 11(4):567. doi.org/10.3390/plants11040567.

[22] Hamilton, A.C. (2004) Medicinal Plants, Conservation and Livelihoods. Biodiversityand Conservation, 13, 1477-1517.

[23] Negi, Shivani & Singh, Pooja & Trivedi, Vijay Laxmi & Rawat, Janhvi & Semwal,Prabhakar. (2024). The current trends and research progress globally in the planttissue culture: 90 years of investigation. Plant Cell, Tissue and Organ Culture(PCTOC). 157. 10.1007/s11240-024-02788-4.

[24] Bharathi JK, Prakash M. In vitro propagation of pharmaceutical and endangered medicinal plants- a mini review . J. Current Opinion Crop Sci., [Internet]. 2022Jan; 2(4): 433-40.

[25] Sharma, Bhagwati & Rani, Jeline & Vc, Vimala & Sable, Poonam & Kumar, Sanjeet& Marndi, Sugimani & amp; Das, Kadambini. Bioactive Compounds of MedicinalPlants: Structure, Function, and Bioactivity. 2025; 9. 34-50. 10.5281/zenodo.17480458.

[26] Kutal, D.H., Kunwar, R.M., Uprety, Y. et al. Selection of medicinal plants fortraditional medicines in Nepal. J Ethnobiology Ethnomedicine 17,592021). doi.org /10.1186 /s13002-021-00486-5